DOE FACT SHEET: Net Zero Performance Analysis and Passive Survivability at Seattle's New North Precinct Police Station

Overview

The City of Seattle was recognized as a Climate Action Champion (CAC) by The White House and the Department of Energy (DOE) in December 2014. In 2015, DOE released a Notice of Technical Assistance (NOTA) to provide CACs with additional opportunities for financial and technical assistance to support and advance their greenhouse gas emissions reduction and climate resilience objectives. DOE's Office of Energy Efficiency and Renewable Energy (EERE) released this NOTA with the goal of strengthening Champions' resilience to extreme weather and prepare for other effects of climate change. The City of Seattle was a multiple awardee of the NOTA.

Lawrence Berkeley National Laboratory (LBNL) provided the Technical Assistance to provide design review, energy modeling and recommendations for achieving net-zero and self sufficiency goals for the Seattle Police Department's North Precinct. The design of the precinct is intended to be self-sustaining on emergency power for at least 72 hours in the event of a large-scale emergency and to maximize the use of onsite renewable power generation.

The current building design was first evaluated for performance from a passive design perspective, addressing how the building would perform under loss of power in terms of providing adequate daylighting and thermal comfort. A successful design strategy has the ability of providing lower annual operating energy requirements and offers a foundation for self-sufficiency during an emergency. Each of the major building features was evaluated in terms of its impact on the overall passive performance and the associated rating given was based on the number of days per year that each specific area of the building would remain comfortable for the typical occupancy. Areas with a high number of unsatisfactory days were analyzed for the root cause of the poor rating and recommendations were provided to improve performance. The initial design was composed of a 3-story 105,000 ft^2 building with an adjacent 157,000 ft^2 parking garage. The building includes a 2-story curtain wall and community area, education center,

Energy Results	
Current Design	The initial design modeled energy use is an EUI of 71.3 kBtu/ft2, utilizing ground-source heat pumps and dedicated outside air systems.
Energy Savings	Reducing plug loads, selecting efficient equipment, careful setpoint control and scheduling is key for overall performance.
Utility Savings	Additional utility savings could be achieved by load-shifting using on-site battery storage required for 72-hr self sufficiency.
Overall Performance	The suite of recommended measures would reduce energy consumption to 60.5 kBtu/ft2 with lighting, glazing, and thermal mass, and insulation improvements.

Proposed design for the new Seattle Police Department North Precincts building.

firing range, holding cells, and office space for 370 officers and staff. The planted roof features a large central skylight and walking path. The parking garage includes a full shade structure supporting photovoltaic panels.

What is passive design?

Passive design is a building design approach that utilizes architectural features and construction practices to allow a building to remain comfortable while requiring very little energy for heating and cooling over the course of a year. Typical features of passive architecture include large amounts of thermal mass, upgraded insulation, smaller window to wall ratios, canopies or other shade structures, controlled natural ventilation, and improved roof designs. Passive designs seek to greatly reduce, or eliminate the need for mechanical heating and cooling systems.

Study Objectives

This project focused on providing energy modeling, design review, and recommendations for the Seattle Police Department North Precinct design team with the goal of achieving annual net-zero energy and emergency operational self-sufficiency for an indefinite period of time in the event of total loss of utility power.

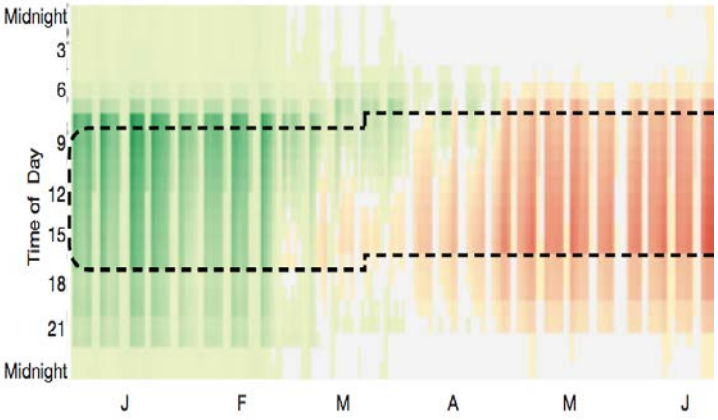
Study Design

Energy modeling using EnergyPlus* and sensitivity analysis were used as the basis of the study, with various proposed features rated as to how well they initially contributed to passive performance. Poorly performing features were further analyzed for improvement. The approach consisted of an initial round of passive analysis with subsequent addition of mechanical system simulation and photovoltaic array sizing.

Results

The study resulted in a suite of recommendations designed to increase the performance of the base design:

- Reduce overhead lighting energy use by maximizing daylight, task lighting, and occupancy-sensor controlled lighting.



Lighting Sensitivity Analysis
Source: Loisos and Ubbelohde

- Increase mechanical ventilation and occupant-controlled natural ventilation, and provide exhaust openings in the central skylight.
- Increase thermal mass by exposing concrete and doubling gypsum board layers on interior partition walls.
- Select high-performance glazing with low U-values for curtain walls. Provide shading to reduce direct sun exposure during the summer and allowing exposure during winter.
- Design the central skylight to provide relief from solar radiation during summer while allowing solar heating during winter.
- Provide the maximum amount of photovoltaic panels, approximately 73,000 square feet in total on the connected parking garage and other non-planted open roof areas.
- Onsite battery storage of at least 2 MWh (mega-Watt hours) for emergency self-sufficiency and load shaping.
- Include load shedding strategies to enable the building to operate for longer-term emergency use.

*https://energyplus.net

Conclusions

The study found that the 72-hour self-sufficiency requirement could be met 50% of the year with solar power and 4 MWh of onsite battery storage alone. An onsite generator would provide the additional power needed to provide coverage for 100% of the year. While the design recommendations greatly reduce heating and cooling energy requirements, further energy reduction and additional on-site power generation would be required to reach annual net-zero energy.

Learn More

Climate Action Champions Initiative: http://energy.gov/epsa/climate-action-champions

City of Seattle: http://www.seattle.gov/environment